LA-UR-16-25540

Title: Gap Analysis of Storage Conditions between NNSS and LANL for SAVY 4000 Use

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Intended for: Report

Issued: 2016-07-25

Gap Analysis of Storage Conditions between NNSS and LANL for SAVY 4000 Use

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Introduction

As part of the gap analysis for utilizing the SAVY 4000® at NNSS, the hydrogen gas generation rate and the effect of atmospheric pressure changes on the maximum normal operating pressure (MNOP) of the SAVY container must be evaluated because the nuclear material characteristics and atmospheric conditions will not be the same for NNSS and LANL. This paper documents this analysis and demonstrates that the LANL SAVY Safety Analysis Report (SAR) (1) is bounding with respect to the Nevada facilities.

Assumptions

For the purposes of this analysis, it is assumed that the material characteristics that affect hydrogen generation rates for nuclear materials stored at NNSS are bounded by the nuclear material characteristics stored at Los Alamos. Ensuring that the material being stored is bounded will be done with administrative controls. Because the NNSS material is bounded by the LANL material as identified in the SAR, it can be assumed that the hydrogen gas generations calculation in the SAR will also cover the material at NNSS. The atmospheric pressure changes will be different for LANL and NNSS. The weather data for each storage location, or a location close, at NNSS was gathered using NOAA records. The weather data allowed the needed information to be gathered for the calculations. The pressure drop across the filter for a maximum wattage of 25 Watts is calculated as the sum of the pressure drop across the filter due to hydrogen gas generation and the pressure drop due to the atmospheric condition changes. The end result was that the NNSS storage conditions are allowed per the LANL SAR.

Approach

The approach and calculations performed were done in the same way as in the paper “Hydrogen gas generation rates and their effect on pressure drop across the filter in SAVY-4000 containers” by D. K. Veirs which is part of the SAVY SAR. The calculations for the hydrogen gas generation were performed to verify that they could be repeated if needed. These calculations are very conservative and as the NNSS material is bound by the LANL material, the gas generation rate calculations are acceptable.

The atmospheric condition effect calculations were done with the NOAA data for each location at NNSS. The atmospheric condition changes drive a volume change and a pressure drop across the filter. The rate of gas that must be expelled is given by:

$$\Delta V_a = \frac{\Delta P}{P} * V \qquad (1)$$

Where ΔP is the rate of maximum pressure change in atmospheric pressure, P is the local atmospheric pressure, V is the volume of the container, and ΔV_a is the rate of volume of air that must be expelled in cc/sec. The maximum change of the atmospheric pressure was found using the NOAA weather data for each NNSS location. The local atmospheric pressure used for each site was the average of the dataset over the provided timeframe. The dataset had pressure data record in 15-minute increments. First analysis of this data showed extremely large pressure changes over the course of a day. Further investigation into the large pressure swings showed that the data was most likely wrong. There were periods with no recorded pressure, followed with a low pressure point, another gap in the data, then the data would return to a normal condition. This led to the question being posed to the contact at NOAA that NNSS had used. The NOAA contact confirmed that the data contained errors. The highest pressure differentials over a day were looked at for issues. For each day that had a high pressure differential, the full data was looked at. This was done until the pressure differential followed an actual, smooth change. The assumption given in the SAR attachment is that this pressure change occurs over 2 hours, which is a conservative compared to the actual data, and that assumption is continued for these calculations.

The pressure drop across the filter will be based on the volume of gas that must be expelled due to atmospheric pressure changes. The assumptions in the SAR for a bounding case is that this out-flow of gas is the filter flow capacity (200 cm^3/sec). The filter is also assumed to be 99% clogged in order to be conservative. The pressure drop across the filter due to atmospheric conditions is:

$$\Delta P_a = \frac{\Delta V_a}{F * 0.01} * 0.25\ kPa \qquad (2)$$

Where ΔP_a is the absolute pressure drop across the container due to atmospheric conditions, ΔV_a is the volume change calculated in Equation 1, F is the filter flow capacity, and 0.01 is the fraction of the capacity assumed to be present.

Results

The results from the LANL SAR are:

LANL						
Local Atmospheric Pressure			78	kPa		
Max pressure change			2.01	kPa		
Assume 2 hour as SAR		$\Delta P=$	0.000279	kPa		
	Volume (cm^3)	V_g (cm^{3}s^{-1})	P_g (kPa)	V_a (cm^{3}s^{-1})	P_a (kPa)	P_{max} 25 watt (kPa)
1-Qt	759	0.0235	0.1764	0.0027	0.0204	0.1968
3-QT	2584	0.0235	0.1764	0.0092	0.0694	0.2457
5-QT	4911	0.0235	0.1764	0.0176	0.1318	0.3082
8-QT	7931	0.0235	0.1764	0.0284	0.2129	0.3893
12-QT	13008	0.0235	0.1764	0.0466	0.3492	0.5256
5-GAL	19012	0.0235	0.1764	0.0680	0.5103	0.6867
10-GAL	39856	0.0235	0.1764	0.1426	1.0699	1.2462

The conclusion from the previous calculation was that the maximum pressure drop in the QT size containers was bounded by 1 kPa and in the GAL size containers was bounded by 2 kPa. In addition, the maximum flow rates calculated from Eq. 2 after solving for ΔV for pressure drops across the filter of 1 kPa and 2 kPa are 8 ml/min and 16 ml/min respectively assuming the filter is 99% plugged.

The results for each of the NNSS storage locations are as follows:

DAF

Local Atmospheric Pressure 89.13 kPa

Max pressure change 2.77 kPa

Assume 2 hour as SAR $\Delta P=$ 0.000385 kPa

	Volume (cm^3)	V_g (cm^3s^{-1})	P_g (kPa)	V_a (cm^3s^{-1})	P_a (kPa)	P_{max} 25 watt (kPa)
1-Qt	759	0.0235	0.1764	0.0033	0.0246	0.2010
3-QT	2584	0.0235	0.1764	0.0112	0.0837	0.2600
5-QT	4911	0.0235	0.1764	0.0212	0.1590	0.3354
8-QT	7931	0.0235	0.1764	0.0342	0.2568	0.4331
12-QT	13008	0.0235	0.1764	0.0561	0.4211	0.5975
5-GAL	19012	0.0235	0.1764	0.0821	0.6155	0.7919
10-GAL	39856	0.0235	0.1764	0.1720	1.2903	1.4666

U1A

Local Atmospheric Pressure 87.93 kPa

Max pressure change 1.97 kPa

Assume 2 hour as SAR $\Delta P=$ 0.000274 kPa

	Volume (cm^3)	V_g (cm^3s^{-1})	P_g (kPa)	V_a (cm^3s^{-1})	P_a (kPa)	P_{max} 25 watt (kPa)
1-Qt	759	0.0235	0.1764	0.0024	0.0177	0.1941
3-QT	2584	0.0235	0.1764	0.0080	0.0603	0.2367
5-QT	4911	0.0235	0.1764	0.0153	0.1146	0.2910
8-QT	7931	0.0235	0.1764	0.0247	0.1851	0.3615
12-QT	13008	0.0235	0.1764	0.0405	0.3036	0.4800
5-GAL	19012	0.0235	0.1764	0.0592	0.4437	0.6201
10-GAL	39856	0.0235	0.1764	0.1240	0.9301	1.1065

BEEF

Local Atmospheric Pressure			87.16	kPa		
Max pressure change			1.93	kPa		
Assume 2 hour as SAR		$\Delta P=$	0.000268	kPa		
	Volume (cm^3)	V_g (cm^3s^{-1})	P_g (kPa)	V_a (cm^3s^{-1})	P_a (kPa)	P_{max} 25 watt (kPa)
1-Qt	759	0.0235	0.1764	0.0023	0.0175	0.1939
3-QT	2584	0.0235	0.1764	0.0079	0.0596	0.2360
5-QT	4911	0.0235	0.1764	0.0151	0.1133	0.2897
8-QT	7931	0.0235	0.1764	0.0244	0.1829	0.3593
12-QT	13008	0.0235	0.1764	0.0400	0.3000	0.4764
5-GAL	19012	0.0235	0.1764	0.0585	0.4385	0.6149
10-GAL	39856	0.0235	0.1764	0.1226	0.9193	1.0957

RNCTEC

Local Atmospheric Pressure			89.13	kPa		
Max pressure change			2.77	kPa		
Assume 2 hour as SAR		$\Delta P=$	0.000385	kPa		
	Volume (cm^3)	V_g (cm^3s^{-1})	P_g (kPa)	V_a (cm^3s^{-1})	P_a (kPa)	P_{max} 25 watt (kPa)
1-Qt	759	0.0235	0.1764	0.0033	0.0246	0.2010
3-QT	2584	0.0235	0.1764	0.0112	0.0837	0.2600
5-QT	4911	0.0235	0.1764	0.0212	0.1590	0.3354
8-QT	7931	0.0235	0.1764	0.0342	0.2568	0.4331
12-QT	13008	0.0235	0.1764	0.0561	0.4211	0.5975
5-GAL	19012	0.0235	0.1764	0.0821	0.6155	0.7919
10-GAL	39856	0.0235	0.1764	0.1720	1.2903	1.4666

Area12Tunnel						
Local Atmospheric Pressure			77.4	kPa		
Max pressure change			1.59	kPa		
Assume 2 hour as SAR		$\Delta P=$	0.000221	kPa		
	Volume (cm^3)	V_g (cm^3s^{-1})	P_g (kPa)	V_a (cm^3s^{-1})	P_a (kPa)	P_{max} 25 watt (kPa)
1-Qt	759	0.0235	0.1764	0.0022	0.0162	0.1926
3-QT	2584	0.0235	0.1764	0.0074	0.0553	0.2317
5-QT	4911	0.0235	0.1764	0.0140	0.1051	0.2815
8-QT	7931	0.0235	0.1764	0.0226	0.1697	0.3461
12-QT	13008	0.0235	0.1764	0.0371	0.2784	0.4547
5-GAL	19012	0.0235	0.1764	0.0542	0.4068	0.5832
10-GAL	39856	0.0235	0.1764	0.1137	0.8529	1.0292

CONCLUSION

Based on the analysis performed, the maximum pressure for all the NNSS sites is below the maximum pressure described in the LANL SAR. These results indicate that the SAVY can be stored at the NNSS site and be covered by the current analysis done in the SAR. All sites are within the 1 kPa MNOP for the quart sizes and the 2 kPa MNOP for the gallon sizes.

References:

1. L.L. Anderson, E.J. Hamilton, E.J. Kelly, P.H. Smith, T.A. Stone, J.G. Teague, D.K. Veirs, and T.F. Yarbro, “Safety Analysis Report for Nuclear Material Packaging and Storage for the Quart-Size SAVY-4000 Containers”, Los Alamos National Laboratory Publication, LA-CP-11-00042, 2011

2. Veirs, D. K. “Hydrogen gas generation rates and their effect on pressure drop across the filter in SAVY-4000 containers”; LA-UR-12-00556; Los Alamos National Laboratory: Los Alamos, NM 87545, 2012.